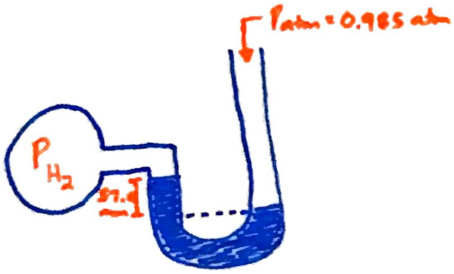
ANSWER KEY

Manometers and Gas Laws Cumulative Practice

Name:____________________

Manometers: **Find the pressures on the gases in the open-end or closed-end tubed manometers. Assume that the liquid in each manometer is mercury (Hg). Show all work!**

1. The mercury level in an open-end manometer is 57.0 mm higher in the gas arm tube connected to hydrogen gas. If the atmospheric pressure is 0.985 atm, what is the pressure of hydrogen gas, in atmosphere (atm)?



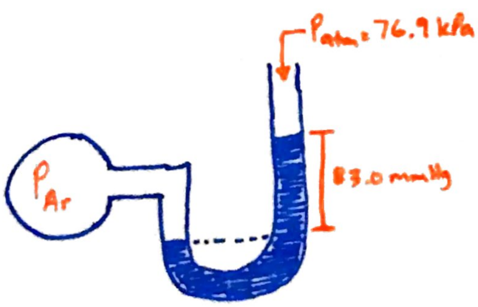
$$\frac{57.0\text{ mm}}{1} \times \frac{1\text{ atm}}{760\text{ mmHg}} = 0.0750\text{ atm}$$

$$P_{gas(H_2)} = P_{atm} - \text{"h"}$$

$$P_{gas(H_2)} = (0.985\text{ atm}) - (0.0750\text{ atm})$$

$$\boxed{P_{gas(H_2)} = 0.910\text{ atm}}$$

2. An open-end manometer connected to a tank of argon gas has a mercury level 83.0 mm higher in the atmospheric arm. If the atmospheric pressure is 76.9 kPa, what is the pressure of the argon gas in kPa?



$$\frac{83.0\text{ mmHg}}{1} \times \frac{101.3\text{ kPa}}{760\text{ mmHg}} = 11.1\text{ kPa}$$

$$P_{gas(Ar)} = P_{atm} + \text{"h"}$$

$$P_{gas(Ar)} = (76.9\text{ kPa}) + (11.1\text{ kPa})$$

$$\boxed{P_{gas(Ar)} = 88.0\text{ kPa}}$$

3. A closed-end manometer is filled with mercury and attached to a container of nitrogen gas. The height differences of mercury in the two arms is 435 mm. What is nitrogen gas's pressure in kPa, atm, and Torr?

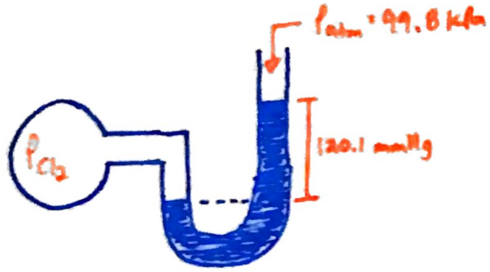
* $P_{N_2} = \text{"h"}$

A: 58.0 kPa → *Show Work* $\frac{435\text{ mmHg}}{1} \times \frac{101.3\text{ kPa}}{760\text{ mmHg}} = \boxed{58.0\text{ kPa}}$

B: 0.572 atm → *Show Work* $\frac{435\text{ mmHg}}{1} \times \frac{1\text{ atm}}{760\text{ mmHg}} = \boxed{0.572\text{ atm}}$

C: 435 Torr → *Show Work* $\frac{435\text{ mmHg}}{1} \times \frac{760\text{ Torr}}{760\text{ mmHg}} = \boxed{435\text{ Torr}}$

4. The mercury level of an open-end manometer is 120.1 mm higher in the atmospheric gas arm than it is to chlorine gas. The atmospheric pressure is 99.8 kPa. What is the pressure of the chlorine gas, in kPa?



$$\frac{120.1\ mmHg}{1} \times \frac{101.3\ kPa}{760\ mmHg} = 16.0\ kPa$$

$$P_{gas(Cl_2)} = P_{atm} + \text{"h"}$$

$$P_{gas(Cl_2)} = (99.8\ kPa) + (16.0\ kPa)$$

$$\boxed{P_{gas(Cl_2)} = 116\ kPa}$$

***Gas Laws*: Show correct *formulas/equations* used, as well as *plug* corresponding values into used *formulas/equations* for full credit. Ensure your final answer adheres to significant figures and includes units.**

5. A balloon is filled with 35.0 L of helium in the morning when the temperature is 20.0 °C. By noon the temperature has risen to 45.0 °C. What is the new volume of the balloon?

$V_1 = 35.0\ L$

$T_1 = 20.0°C = 293\ K$

$V_2 = ?$

$T_2 = 45.0°C = 318\ K$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow V_2 = \frac{V_1 T_2}{T_1} \checkmark$$

$$V_2 = \frac{(35.0\ L)(318\ K)}{(293\ K)}$$

$$\boxed{V_2 = 38.0\ L}$$

6. A balloon that can hold 85 L of air is inflated with 3.5 moles of gas at a pressure of 1.0 atm. What is the temperature in °C of the balloon?

$V = 85\ L$

$n = 3.5\ moles$

$P = 1.0\ atm$

$T = ?$

$R = 0.0821\ \frac{L\cdot atm}{mol\cdot K}$

$$PV = nRT \rightarrow T = \frac{PV}{nR} \checkmark$$

$$T = \frac{(1.0\ atm)(85\ L)}{(3.5\ mol)(0.0821\ \frac{L\cdot atm}{mol\cdot K})} = 296\ K$$

$$°C = K - 273 \rightarrow °C = (296\ K) - (273)$$

$$\boxed{°C = 23.0°C}$$

7. 6.00 L of gas in a piston at a pressure of 1.00 atm is compressed until the volume is 3.55 L. What is the new pressure inside the piston?

$$P_1V_1 = P_2V_2 \rightarrow P_2 = \frac{P_1V_1}{V_2} \checkmark$$

$V_1 = 6.00\ L$ $V_2 = 3.55\ L$

$P_1 = 1.00\ atm$ $P_2 = ?$

$$P_2 = \frac{(1.00\ atm)(6.00\ L)}{(3.55\ L)} \rightarrow \boxed{P_2 = 1.69\ atm}$$

8. An airtight container with a volume of 4.25 x 10^4 L, an internal pressure of 101.325 kPa, and an internal temperature of 15.0 °C is washed off the deck of a ship and sinks to a depth where the pressure is 175 atm and the temperature is 3.00 °C. What will the volume of the gas inside be when the container breaks under the pressure at this depth?

$V_1 = 4.25 \times 10^4 L$
$P_1 = 101.325 kPa$
$T_1 = 15.0°C = 288 K$
$V_2 = ?$
$P_2 = 175 atm$
$T_2 = 3.00°C = 276 K$

$$\frac{101.325 \text{ kPa}}{1} \times \frac{1 \text{atm}}{101.3 \text{ kPa}} = 1.00 \text{ atm}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow V_2 = \frac{P_1V_1T_2}{P_2T_1} ✓$$

$$V_2 = \frac{(1.00 \text{ atm})(4.25\times10^4 \text{ L})(276 \text{ K})}{(175 \text{ atm})(288 \text{ K})}$$

$V_2 = 233 L$

→ Extra Info

9. A 30.0 L sample of nitrogen inside a rigid, metal container at 20.0 °C is placed inside an oven whose temperature is 50.0 °C. The pressure inside the container at 20.0 °C was at 3.00 atm. What is the pressure of the nitrogen after its temperature is increased?

$T_1 = 20.0°C = 293 K$
$P_1 = 3.00 atm$
$T_2 = 50.0°C = 323 K$
$P_2 = ?$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow P_2 = \frac{P_1T_2}{T_1} ✓$$

$$P_2 = \frac{(3.00 \text{ atm})(323 \text{ K})}{(293 \text{ K})}$$

$P_2 = 3.31 atm$

10. CHALLENGE: If 5.00 moles of O_2 and 3.00 moles of N_2 are placed in a 30.0 L tank at 255 °C, what will the pressure of the resulting mixture of gases be?

$n_{O_2} = 5.00 mol$
$n_{N_2} = 3.00 mol$
$V = 30.0 L$
$T = 255°C = 528 K$
$P = ? atm$
$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$
↓
$PV = nRT$

① $P_{O_2} = \frac{nRT}{V}$

$$P_{O_2} = \frac{(5.00 \text{ mol})(0.0821 \frac{L\cdot atm}{mol\cdot K})(528 \text{ K})}{(30.0 \text{ L})} \rightarrow P_{O_2} = 7.22 \text{ atm}$$

② $P_{N_2} = \frac{nRT}{V}$

$$P_{N_2} = \frac{(3.00 \text{ mol})(0.0821 \frac{L\cdot atm}{mol\cdot K})(528 \text{ K})}{(30.0 \text{ L})} \rightarrow P_{N_2} = 4.33 \text{ atm}$$

③ $P_{Total} = P_{O_2} + P_{N_2}$

$P_{Total} = (7.22 atm) + (4.33 atm) \rightarrow P_{Total} = 11.6 atm$

Partial Pressure: **Show all work for full credit! Ensure your final answer adheres to significant figures and includes units.**

11. The total pressure in a closed container of four mixed gases is 231.5 kPa. The partial pressure of helium is 23.2 Torr, oxygen is 43.3 Torr, and argon is 54.3 Torr. The fourth gas in the mixture is carbon dioxide. What is its partial pressure in *kPa*?

$(23.2\ Torr) + (43.3\ Torr) + (54.3\ Torr) = 120.8\ Torr$

$\frac{120.8\ Torr}{1} \times \frac{101.3\ kPa}{760\ Torr} = 16.1\ kPa$

$P_{Total} = P_{He} + P_{O_2} + P_{Ar} + P_{CO_2} \rightarrow P_{CO_2} = P_{Total}[- P_{He} - P_{O_2} - P_{Ar}]$ ✓

$P_{CO_2} = (231.5\ kPa) - (16.1\ kPa)$

$P_{CO_2} = 215\ kPa$

12. Find the total pressure ***(in atm)*** for a mixture that contains six gases with partial pressures of 5.45 kPa, 3.56 kPa, 2.45 kPa, 4.95 kPa, 8.34 kPa, and 7.34 kPa.

$P_{Total} = P_1 + P_2 + P_3 + P_4 + P_5 + P_6$

$P_{Total} = (5.45\ kPa) + (3.56\ kPa) + (2.45\ kPa) + (4.95\ kPa) + (8.34\ kPa) + (7.34\ kPa) = 32.09\ kPa$

$P_{Total} = \frac{32.09\ kPa}{1} \times \frac{1\ atm}{101.3\ kPa} \rightarrow P_{Total} = 0.317\ atm$

13. What is the partial pressure of methane gas in a mixture of methane and helium if the total pressure is 345 mm Hg and the partial pressure of helium is 136 mm Hg?

$P_{Total} = P_{He} + P_{CH_4}$

$P_{CH_4} = P_{Total} - P_{He}$

$P_{CH_4} = (345\ mmHg) - (136\ mmHg)$

$P_{CH_4} = 209\ mmHg$